



AMERICAN ASSOCIATION OF WINE ECONOMISTS

AAWE WORKING PAPER

No. 94

Economics

INFLUENCE OF PRODUCT ASSORTMENT
ON THE EFFICIENCY OF GRAPE-GROWING
FAMILY FARMS IN MACEDONIA
- A DEA APPROACH

Gordana Manevska-Tasevska

December
2011

www.wine-economics.org

Influence of product assortment on the efficiency of grape-growing family farms in Macedonia¹ - DEA approach

Gordana Manevska-Tasevska

Swedish University of Agricultural Sciences, Department of Economics,
P.O. Box 7013, SE-750 07 Uppsala Sweden.

Contact details: Tel: +46 (0) 76 5929587, E-mail: gordana.tasevska@slu.se

Abstract

The influence of grape assortment in terms of assortment size and product function/product consistency on the technical efficiency of grape-growing family farms in Macedonia was analyzed. A two-stage Data Envelopment Analysis (DEA) method extended with bootstrapping was applied to the three-year average (2006-2008) of a panel dataset for 300 farms. In the first stage, output-orientated ordinary DEA and bias-corrected technical efficiency scores accompanied with confidence intervals were obtained. In the second stage, the impact of grape assortment characteristics on the efficiency scores obtained was assessed. The analysis revealed very high potential for revenue increases. Farmers with lower variety diversification, specializing in growing local and regional varieties and table grape varieties, achieved higher efficiency. Thus the ongoing revitalization and investments in Macedonian grape assortment should primarily be directed towards regionally recognized and table grape varieties. Grape variety diversification is generally not recommended.

Keywords: assortment dimension, farm efficiency, grape production, product diversification, rural development

¹ Republic of Macedonia is a constitutional name of the country, provisionally referred to within the United Nations system as 'the former Yugoslav Republic of Macedonia' (UNSC Resolution 817/1993).

I. Introduction

During the past decade, interventions for restructuring and modernizing viticulture have been of great interest for the winemaking Western Balkan Countries (WBCs) and the Early Transition Countries (ETCs) (Food and Agricultural Organization 2009). Within the platform for rural development and support from the national Rural Development Programs (RDP), grape producers have been encouraged to uproot old vineyards consisting of local and regional grape varieties and replace them with recognized European grape varieties. Macedonia, which is used as a case study in this paper, is an EU aspirant country, and adjustments to match EU regulations and practices, including wine regulations, are considered to be the key to improving the competitiveness and environmental sustainability of the Macedonian wine sector. However, adjustments in the grape assortment in Macedonia may not necessarily be sustainable (Bozinovski, personal communication, 2011)². Moreover, it has not been proven to be appropriate for achieving higher farm efficiency, which is a key objective of the ongoing RDPs.

Since 2000, the acreage of Macedonian vineyards has declined from 28 to 21 thousand hectares (SS0 2011). Inadequate replacement of old plantations has been proposed as a possible explanation for this situation (Z. Bozinovski, personal communication 2011). During revitalization and replacement of old plantations, two characteristics need to be taken into consideration: First, vines are perennial plants and thus revitalization and replacement of old plantations should be based on a long-term strategy. Second, Macedonian grape production is industry-orientated (80% of total production is processed into wine), and thus changes in the grape assortment should meet the demands of the wine sector and enable continuous development of both the grape and wine sectors. The government authorities in Macedonia have introduced subsidies for uprooting old plantations and their replacement with recommended varieties (Book of

² Personal communication: Professor Zvonimir Bozinovski at the Department for Viticulture and Wine Production, Faculty for Agricultural Sciences and Food – Skopje, University St Cyril and Methodius. *What is the most appropriate assortment for the viticulture in the Republic of Macedonia*. March 15th, 2011, Skopje R. Macedonia.

Rules on classification of wine grape varieties OG 6/2007 Annex 21) consisting of European, regional and local grape varieties (MAFWE 2007). However, variety recommendation is only based on the (climatic or agri-environmental) appropriateness of a certain grape variety to be grown in a specific district. Growing demand for rootstocks of European grape varieties in all WBC and ETC countries has been reported by the FAO (Food and Agricultural Organization 2009). On the other hand, professionals (Z. Bozinovski, personal communication 2011) support uprooting of old vineyards, but emphasize the importance of strategically planned replacement based both on the variety adaptability to a specific district and the long-term marketing strategy. This suggests that the regional and local varieties need to be favored. Experts believe that wines need to be seen as differentiated products, and adjustments of Macedonia to the grape assortments and practices of the major wine-making European countries would mean entering the globalization world, where value-added is difficult to achieve. Therefore, Macedonian viticulture and wine strategy should be aimed at brand development from a grape assortment that corresponds with the local resources and conditions and gives high-quality wines. Publicly presented interest in brand development has also been emphasized by Macedonian wine producers. They suggest a single brand called 'Macedonian wines' to be used for all wine exports. Nacka (2011) explains that brand development is essential for strengthening the competitiveness of the Macedonian wine sector, and adjustments with the EU regulation are necessary for quality standards harmonization and their application. For Macedonian viticulture, there is a suggestion that old plantations be predominantly replaced with recognized regional varieties and table grape varieties, with the Vranec and Stanusina varieties planted on at least 50% and 10%, respectively, of the wine-grape growing area in Macedonia (Z. Bozinovski, personal communication 2011). Similarly, the winemaking companies have proposed that Vranec becomes the national choice for wine grape production. Based on current data, Vranec comprises only 25% of the total planted area and 28% of the total revenue obtained (Table 1).

The issue of product modernization in assortment terms, even though included in RDPs to date, has not been analyzed as a factor that determines farm efficiency, whereas viticulture remains one of the least explained agricultural enterprises within the farm efficiency concept. A few studies examine the influence of crop diversification on farm

efficiency (Bojnec and Latruffe 2009; Brümmer 2001; Haji 2007; Paul and Nehring 2005). On the other hand, studies analyzing the impact of rural development policy measures on farm efficiency have devoted more attention to the use of the Farm Credit Programs (Brümmer and Loy 2000; Rezitis et al. 2003) and CAP direct payments (Kleinhanß et al. 2007; Latruffe et al. 2009; Zhu et al. 2008). These studies show that measures covered by funding provided by RDPs may not necessarily be appropriate for efficient agricultural production.

This study, sought to obtain empirical evidence on the importance of grape assortment in attaining higher farm efficiency through analyzing grape-growing family farms in the Tikvesh Vineyard district of Macedonia. Although decisions on choice of variety are driven by a combination of inertia, historical precedent, ad hoc criteria and rational decision-making (Ramdas 2003, pp 80), the political influence on such decisions should not be overlooked. This study examined the importance of research discussions when policy interventions are about to take place. Variety management is of great interest to both economists and policy-makers (Haji 2007). More knowledge about how farm efficiency is affected by the grape assortment could help policy-makers to formulate better agricultural policies, and thereby enhance farm efficiency, which by definition is the main objective of the ongoing RDPs in Macedonia (2007-2013).

A. Dimensions of Product Assortment

Assortment management is crucial for successful business practice, and a balance between assortment decisions, revenues and costs is necessary for long-term profit maximization (Ramdas 2003). Product variety originates from differences in physical form and product function (Ramdas 2003). Hart and Rafiq (2006) imposed assortment consistency as an alternative assortment dimension, where the consistency is interpreted as a specialization characteristic, and increased specialization suggests closer relatedness across categories. In the literature, crop product varieties have been expressed as number of varieties per farm (Haji 2007; Paul and Nehring 2005) or as a concentration index (Bojnec and Latruffe 2009; Coelli and Fleming 2004; Llewelyn and Williams 1996).

Variety creation as strategic product planning incorporates decisions on: the type of products to be offered, the number of products to be offered, potential markets,

technology selection and the time frame for product introduction (Krishnan and Ulrich 2001; Ramdas 2003). In this paper product selection was analyzed and grape assortment planning considered. The influences of two assortment dimensions were distinguished: 1) Product diversification in terms of the number of grape varieties on the farm; 2) product diversification in terms of the product function/product consistency dimension, represented by three production options: regional/local wine grape varieties, European wine grape varieties and table grape varieties. Variety creation by firms allows a certain degree of synergy among the products, which originates from the technological process, common production process, knowledge, etc. (Ramdas 2003). One may argue that growing a different grape variety differs from growing a different crop. Although the production conditions are similar for all grape varieties, as they are for different crops, different grape varieties have specific biological characteristics (resistance to weeds, diseases, frost, etc.), technological potential (yield, content of sugar and dry materials, etc.) and quality, and thus the demand for a certain variety on the market and the purchase price differ.

Specialization in production is expected to lead to efficiency gains resulting from the specialist skills and knowledge, economies of scale, time savings through not switching between different tasks, avoidance of bottlenecks in the allocation of resources, etc. (Coelli and Fleming (2004). Diversification, as opposed to specialization, ensures a better outcome in an uncertain production environment. The empirical evidence suggests that increasing assortment size is not a guarantee of higher profits in the long run, and can even decrease competitiveness (Ramdas 2003). A negative effect of crop diversification on farm efficiency has been reported by Haji (2007) and Brumer (2001). Paul and Nehring (2005) found crop diversification to be useful for the economic performance of the US agricultural sector, while Coelli and Fleming (2004) found diversification of crop activities it to be beneficial for the smallholder farming system in Papua New Guinea.

Product assortment dimension is of great interest to both buyers and producers. From a buyer perspective, two opposing viewpoints are applicable. The first, related to buyers without strict product preferences, is that greater assortment size is more beneficial, allowing consumers to find satisfactory products and enhance the enjoyment of shopping (Oppewal and Koelemeijer 2005). In contrast, for buyers with strict preferences less is

preferable to more, and assortment size is perceived as confusing (Hoch et al. 1999). In this study the product assortment issue was approached from the producer's perspective. However, the product assortment is not impervious to environmental changes. It is affected by changes in buyers' preferences, political decisions, production capacity and technology. Chakravarthy (1986) classifies the transformation processes of a firm into adaptive specialization and adaptive generalization. The former involves generating a net surplus by exploiting the current resources and the latter is the subsequent step, when a firm's net surplus is used for investments that guarantee long-term survival. Chakravarthy (1986) points out that a well-managed firm should be able to pursue adaptive generalization along with adaptive specialization, and that replacements should take place on a regular basis. Inadequate transformation in terms of vine replacement has caused a dramatic decline in the acreage of Macedonian vineyards. Since 2007, uprooting of old vines and their re-plantation is fully supported by the RDP (MAFWE 2007), but the objectives of the RDP need to be fulfilled.

II. Method

The influence of the selected grape assortment characteristics on farm efficiency was analyzed by the two-stage method for efficiency analysis (Coelli et al. 2005). This is a common method for analyzing the influence of various production and environmental factors, including the assortment characteristics (Haji 2007), on farm performance.

In the first stage, Data Envelopment Analysis (DEA) (Charnes et al. 1978) extended by homogeneous bootstrapping application for non-parametric models (Simar and Wilson 1998; Simar and Wilson 2000) was applied. Ordinary DEA and bias-corrected output-orientated technical efficiency (TE) scores accompanied by their confidence intervals (for the bias-corrected TE scores) were obtained. DEA is a linear programming model used for measuring the relative efficiency of different operating Decision Making Units (DMU). By generating efficiency scores for each participating unit, it constructs a frontier containing the best performing units. All deviations from the frontier are assumed as inefficiency. The output-oriented technical efficiency score generated explains the degree to which each grape producer can maximize output (in this case in monetary units,

see Table 1) for a given scale of input use. Macedonian grape growers have more adjusted practices for the use of inputs, but vary in production assortment and quality, improvements which require plant revitalization and assortment strategy (Manevska-Tasevska and Hansson 2011). Since the latter study characterized the assortment characteristics as being more influential for the output generated, output-orientated technical efficiency was deemed more appropriate for the present study. The bootstrapping application was initiated to resolve the problem that the data gathering process itself influences the validity of the estimated efficiency score and that the efficiency scores obtained with ordinary DEA have no statistical inference. With the bootstrapping application, both considerations were assumed to be solved. The procedure for non-parametric efficiency analysis with homogeneous bootstrapping application (Simar and Wilson 1998; Simar and Wilson 2000) was carried out in the following steps: In **Step 1**, the output-orientated technical efficiency scores, under the assumption of variable returns to scale (Banker et al. 1984) for each farm i were computed as (equation 1):

$$\begin{aligned}
 & \max_{\hat{\phi}_i, \lambda} \hat{\phi}_i \\
 \text{Subjected to} & \quad -\hat{\phi}_i y_i + Y\lambda \geq 0, \\
 & \quad x_i - X\lambda \geq 0, \\
 & \quad N1' \lambda = 1 \\
 & \quad \lambda \geq 0 \\
 & \quad 1 \leq \hat{\phi}_i < \infty
 \end{aligned} \tag{1}$$

where $\hat{\phi}_i$ is a scalar that measures the technical efficiency for each farm i ; X and Y are matrices of the inputs and outputs of all farms in the observation N ; $Y\lambda$ and $X\lambda$ are the efficient projections on the frontier; and $N1' \lambda = 1$ is a constraint for allowing variable returns to scale.

In **Step 2**, the estimated output-orientated technical efficiency scores $\hat{\phi}_i$, $i = 1, \dots, n$, or $\hat{\phi}_1, \dots, \hat{\phi}_n$, were bootstrapped, and thus random samples of size n , $\hat{\phi}_{1b}^*, \dots, \hat{\phi}_{nb}^*$ were generated.

Step 3 involved re-sampling the ordinary efficiency scores and the original dataset, and thus a pseudo-dataset y^* and x^* was constructed for each i^{th} farm in the sample. For the output-orientated technical efficiency, the pseudo-dataset was: $x_{ib}^* = (\hat{\phi}_i / \hat{\phi}_{ib}^*)x_i, i = 1, \dots, n$, and $y_i^* = y_i$.

In **Step 4**, the bootstrap estimates for the output-orientated technical efficiency $\hat{\phi}_{ib}^*$ of $\hat{\phi}_i$, for $i = 1, \dots, n$, were then solved by the technical efficiency equations (1).

In **Step 5** the procedures from Step 2 to Step 4 were repeated 2000 times, and provided a set of estimates $\hat{\phi}_{ib}^*, b = 1 \dots B$; where B is the number of repetitions.

In **Step 6** the confidence intervals for the real efficiency scores ϕ_i were derived from the empirical distribution of the estimated pseudo-efficiency scores $\hat{\phi}_{1b}^*, \dots, \hat{\phi}_{nb}^*; b = 1, \dots, B$, where $\hat{\phi}_{1b}^*, \dots, \hat{\phi}_{nb}^*; b = 1, \dots, B$ was used for finding values of \hat{a}_α and \hat{b}_α , such that:

$$\Pr(-a_\alpha \leq \hat{\phi}_i - \phi_i \leq -b_\alpha) = 1 - \alpha \quad (2)$$

is approximated. The procedure involved sorting the values of $(\hat{\phi}_{ib}^* - \hat{\phi}_i)$ for all $b = 1, \dots, B$, in decreasing order. The $(\alpha/2 * 100)$ percent of elements was deleted at both ends of the sorted list, whereas $-\hat{a}_\alpha$ and $-\hat{b}_\alpha$ were found at the truncated endpoints of the list with $\hat{a}_\alpha \leq \hat{b}_\alpha$. The percentage confidence interval for the efficiency $(1 - \alpha)$ of the i^{th} farmer is:

$$\hat{\phi}_i + \hat{a}_\alpha \leq \hat{\phi}_i + \hat{b}_\alpha \quad (3)$$

In the second stage, the influence of product assortment on the output-orientated technical efficiency values obtained was analyzed. Four models were tested. Tobit (Table 3) and Truncation regression (Table 4) were applied. In the existing efficiency studies where Tobit regression is applied in the second stage, efficiency scores are characterized as by definition being censored at 1, which Shimar and Wilson criticize as a “nonsense” (2008) and claim that the second stage involves truncated rather than a censored error term. In the models presented in this study, Tobit and the Truncated regression assessed the relationship between both the ordinary DEA output-orientated efficiency scores (in

Model 1 and Model 3 respectively) and the bias-corrected output-orientated technical efficiency scores (Model 2 and Model 4) as a dependent variable and a vector of assortment characteristics (as independent variables), expected to influence farm efficiency. In Model 2 and Model 4, bias-corrected bootstrapped standard errors derived with regular bootstrapping in STATA were used (Manevska-Tasevska and Hansson 2011). In particular, the second bootstrapping is proposed for corrections of regression results that are assumed to be biased, in cases where a high correlation between the first-stage and second-stage variables exists. This implies heteroscedasticity in the regression analysis, with error terms correlated with the independent variables. Double-bootstrapping purposely designed for non-parametric analysis (Simar and Wilson 2007) is an alternative option for such analysis. It involves application of a bootstrapping procedure for non-parametric analysis in both the first and second stage of the analysis. Model 2 and Model 4 do not follow the Simar and Wilson (2007) double-bootstrapping procedure, but as it uses heteroscedasticity-corrected standard deviations it is assumed to solve the heteroscedasticity problem (Manevska-Tasevska and Hansson 2011). The bootstrapping promotion (Simar and Wilson 1998; Simar and Wilson 2000; Simar and Wilson 2007) has provoked many empirical comparisons of the results obtained with the common two-stage (Coelli et al. 2005) and bootstrap two-stage approach. Yet, apart from the bias-corrected technical efficiency scores (which are obtained in the first bootstrapping procedure) being lower than the ordinary DEA estimates, substantial differences in the sign and the statistical significance of the estimated regression coefficient have not been found (e.g. Afonso and St. Aubyn 2006; Larsén 2010; Latruffe et al. 2008; Manevska-Tasevska and Hansson 2011).

III. Data and variables

A survey conducted via face-to face interviews at 300 grape-growing family farms in the Tikvesh Vineyard District of Macedonia provided a panel dataset for three production years (2006-2008). Each production year corresponded to a calendar year, from 01 January to 31 December. Data gathering was performed in two periods (June 2007, and January/February 2008) by six local survey-trained interviewers. As an official register of

grape growers was not available, a random sampling method was not possible. Sampling was therefore approached by a combination of purpose-based and quota-sampling methods, where each interviewer was responsible for establishing contact and collecting data directly from 50 farms. Participation in the survey was limited to commercial grape-growing family farms with a production area above 0.3 ha, and a willingness to participate and provide data for the whole survey period (2006-2008). In Macedonia, grape-growing family farms produce 70% of the total grape production (SS0 2007), and the Tikvesh Vineyard District is one of the most important grape production regions for quality wines. All farms surveyed specialized in grape production, with on average 3.2 grape varieties on the farm. According to the dataset, regional and local vine varieties were planted on 67.6% of the total grape growing area. Recognized European wine varieties were grown on 22.7% of the total grape growing area and table grape varieties on 7.6%. The traditional regional variety Vranec was planted on 25% of the total area, but Stanusina only on 1.4%. Both these varieties are highly recommended by local experts (Z. Bozinovski, personal communication 2011) and according to expert recommendations should cover 60% of the wine grape area in total. In particular, it is recommended that Vranec be cultivated on 50% of the wine grape area. At national level, wine grapes are planted on 87% of the total vineyard area and table grape varieties on the remaining 13% (SS0 2007).

One output and four input variables were used for calculation of the output-orientated technical efficiency scores, while four assortment variables were expected to explain the farm efficiency. Many other variables associated with the farm and farmer characteristics can influence efficiency, but such variables were outside the scope of this study. Descriptive statistics for the dataset analyzed are presented in Table 1.

Although the survey provided a panel dataset for three production years, all variables were represented as a mean value for 2006-2008. For the efficiency analysis, mean revenue (MReven) expressed in Euro and normalized per hectare was used as an output variable. Mean cost for materials (MMaterials), mean cost for hired labor (MLabor) and mean cost for energy and services (MEnSe), all in Euro per hectare, and the mean total area in hectares were used as input variables. The assortment characteristics expected to influence the technical efficiency scores were represented by two sets of variables. The

first set explained the assortment consistency/product function framework assortment dimension and contained three variables, all given as mean revenue in Euro per hectare: local and regional vine varieties (MRLRGV), European wine grape varieties (MREWGV) and table grape varieties (MRTGV). The second set explained the assortment size and was represented by the average number of varieties per farm (MNV).

Table 1

Descriptive statistics: Input, output and assortment characteristics.

Three-year mean values for 2006-2008

| <i>Variable</i> | <i>Farms</i> | <i>Mean</i> | <i>St dev.</i> | <i>Min</i> | <i>Max</i> |
|---|--------------|-------------|----------------|------------|------------|
| Total area (TArea) ha | 300 | 2.0 | 1.2 | 0.3 | 7.0 |
| Mean revenue (MReven) €/ha | 300 | 2704.6 | 1032.9 | 706.4 | 8337.9 |
| Mean revenue of local and regional varieties (MRLRGV) €/ha | 279 | 2681.7 | 1333.4 | 711.7 | 18879.5 |
| Mean revenue of European wine grape varieties (MREWGV) €/ha | 158 | 2904.2 | 1460.7 | 1087.4 | 16810.9 |
| Mean revenue of table grape varieties (MRTGV) €/ha | 102 | 4465.6 | 2306.5 | 699.1 | 12381.7 |
| Proportion of regional and local varieties (SRLRGV) % | 300 | 67.6% | | | |
| Proportion of European wine grape varieties (SEWGV) % | 300 | 22.7% | | | |
| Proportion of table grape varieties (STGV) % | 300 | 7.6% | | | |
| Proportion of Vranec in the total planted area (SVA) % | 300 | 25.0 | | | |
| Proportion of Vranec in the total revenue (SVR) % | 300 | 25.0 | | | |
| Proportion of Stanusina in the total area (SSA) % | 300 | 1.4 | | | |
| Proportion of Stanusina in the total revenue (SSR) % | 300 | 1.2 | | | |
| Mean number of varieties per farm (MNV) N ^o | 300 | 3.2 | 1.5 | 1.0 | 9.0 |
| Mean cost of materials used (MMaterials) €/ha | 300 | 414.0 | 167.7 | 79.5 | 1170.1 |
| Mean cost of hired labor used (MLabor) €/ha | 300 | 136.1 | 107.3 | 0.0* | 704.0 |
| Mean cost of energy and services (MEnSe) €/ha | 300 | 237.7 | 118.4 | 84.2 | 1178.9 |

*A case when farms use only family labor

As can be seen in Table 1, the highest maximum achieved output was recorded from the local and regional varieties, while the highest mean revenue value was obtained from the table grape varieties. While encouraging in terms of farm success, such figures do not provide information on input use efficiency and thus further analysis is necessary. The maximum number of grape varieties per farm was 9, which is far above the mean (3.2, standard deviation 1.5). As higher assortment size requires a higher degree of knowledge, a negative influence was an expected outcome. The correlation matrix for the grape assortment characteristics is presented in Table 2.

Table 2

Correlation matrix: Grape assortment characteristics

| | SRLGV | MRLRGV | SEWGV | MREWGV | STGV | MRTGV | MNV |
|--------|---------|---------|---------|---------|---------|--------|--------|
| SRLGV | 1.0000 | | | | | | |
| MRLRGV | 0.0947 | 1.0000 | | | | | |
| SEWGV | -0.6375 | -0.1187 | 1.0000 | | | | |
| MREWGV | -0.1908 | 0.1445 | 0.0847 | 1.0000 | | | |
| STGV | -0.4761 | -0.0402 | -0.3347 | 0.0966 | 1.0000 | | |
| MRTGV | 0.1319 | 0.4146 | -0.2892 | 0.0252 | 0.0795 | 1.0000 | |
| MNV | -0.1279 | -0.1727 | 0.0805 | -0.0884 | -0.0360 | 0.2924 | 1.0000 |

A rather high negative correlation was found between SRLGV and SEWGV and a moderate negative correlation between SRLGV and STGV, which is understandable since if one increases the other decreases. In the model (second-stage analysis), this was the reason why different grape varieties were not represented with such index numbers, as proposed by Coelli and Fleming (2004) and were not part of the regression analysis. A moderate positive correlation also existed between MRLRGW and MRTGV. Weak evidence for the correlation existed between the number of grape varieties on the farm, the farm revenue obtained from different grape groups and the proportion of different groups. In particular, Table 2 shows that higher revenue is obtained from local varieties and regional and European varieties if fewer grape varieties are grown on the farm, whereas the opposite applies for table grape varieties. As the proportion of table grape varieties and local and regional varieties increases, the mean number of varieties per farm

decreases. Less specialized farms have a higher proportion of European grape wine varieties. Table 2 suggests that better results in terms of higher mean revenue per hectare can be obtained if table grape production consists of more grape varieties. From a technological perspective, this means that such production can ensure grape supply for the longer consumption period, whereas wine grape production, for both European and regional/local varieties, should tend towards specialization. Mixed production of table and regional/local grape varieties is also profitable.

IV. Results

For the period 2006-2008, the average ordinary DEA output-orientated technical efficiency score for the grape-growing family farms analyzed here was 53%, while the bias-corrected technical efficiency score was 39%. The 95% confidence intervals of the bias-corrected technical efficiency score ranged between 0.365 and 0.458. An influence of grape assortment on the output-orientated technical efficiency scores obtained was detected. The results of the regression analysis are presented in Table 3 and Table 4. The results allow empirical comparisons of the outcomes obtained with the common two-stage (Coelli et al. 2005) vs. the bootstrap two-stage approach and Tobit vs. Truncated regression. In all models (Model 1 to Model 4), similar results with respect to the sign and the statistical significance of the explanatory variables were obtained, as also reported in recent studies (Afonso and St. Aubyn 2006; Larsén 2010; Latruffe et al. 2008; Manevska-Tasevska and Hansson 2011). A statistically significant positive influence was obtained from the regional and local grape varieties and table grape varieties. European wine grape varieties had a positive but statistically non-significant influence. The number of varieties per farm had a statistically significant negative influence. Statistical significance of the constant was obtained with Model 1 and Model 3. The goodness of fit analysis is presented by McKelvey & Zavoinas R², which gave a value of 0.451 for Model 1 and 0.418 for Model 2.

Table 3

Tobit regression analysis: Ordinary DEA and bias-corrected technical efficiency (TE) scores regressed on selected assortment characteristics

| Assortment characteristics | Model 1: Ordinary DEA TE | | Model 2: Bias-corrected TE* | |
|---|--------------------------|--------------------|-----------------------------|--------------------|
| | Coef (Std. err) | P>t | Coef (Boot Std. Err) | P>z |
| Regional and local wine grape varieties | .000015 (5.75e-06) | 0.013 ^b | .000011 (4.93e-06) | 0.028 ^b |
| European wine grape varieties | 5.84e-07 (1.60e-06) | 0.718 | 1.11e-06 (2.88e-06) | 0.699 |
| Table grape varieties | 5.77e-06 (2.04e-06) | 0.007 ^a | 5.64e-06 (1.80e-06) | 0.002 ^a |
| No. of varieties on the farm | -.028702 (.016231) | 0.085 ^c | -0.31 (0.145593) | 0.033 ^b |
| Constant | .2615623 (.130099) | 0.052 ^c | .185625 (.1353232) | 0.170 |
| Sigma | .144556 (.016610) | | .1367248 (.0198271) | |
| McKelvey & Zavoinas R2 | | 0.451 | | 0.418 |

Note 1: ^a statistically significant at 1%, ^b statistically significant at 5%, ^c statistically significant at 10%,

* In the regression Model 2, 2000 bootstrapping replications were used

Table 4

Truncated regression analysis: Ordinary DEA and bias-corrected technical efficiency (TE) scores regressed on selected assortment characteristics

| Assortment characteristics | Model 1: Ordinary DEA TE | | Model 2: Bias-corrected TE* | |
|---|--------------------------|--------------------|-----------------------------|--------------------|
| | Coef (Std. err) | P>t | Coef (Boot Std. Err) | P>z |
| Regional and local wine grape varieties | .000014 (5.46e-06) | 0.009 ^a | .000011 (5.09e-06) | 0.033 ^b |
| European wine grape varieties | 4.18e-07 (1.53e-06) | 0.784 | 1.11e-06 (2.75e-06) | 0.686 |
| Table grape varieties | 5.58e-06 (1.94e-06) | 0.004 ^a | 5.64e-06 (1.73e-06) | 0.001 ^a |
| No. of varieties on the farm | -.029083 (.0155292) | 0.061 ^c | -0.31 (0.146643) | 0.035 ^b |
| Constant | .2824952 (.1226453) | 0.021 ^b | .185625 (.1345584) | 0.168 |
| Sigma | .1384419 (.0152883) | 0.000 ^a | .1367248 (.0210436) | 0.000 ^a |

Note 1: ^a statistically significant at 1%, ^b statistically significant at 5%, ^c statistically significant at 10%,

* In the regression Model 2, 2000 bootstrapping replications were used

V. Discussion and conclusions

The results revealed that there is potential for a 47% (61% when bootstrapped standard errors in the regression analysis were used) increase in average revenue on the farms analyzed here if farmers could manage to organize their production more efficiently. Assortment characteristics have been pointed out as a possible solution for better output

(Manevska-Tasevska and Hansson 2011), and have also been shown to be influential for farm efficiency (Haji 2007). As expected, a statistically significant positive influence on technical farm efficiency was obtained from the regional/local grape varieties, and for the table grape varieties. Macedonian grape growers apply the same production practices for the local/regional and the European wine grape varieties, although the biological and technological characteristics of these groups differ. European wine grape varieties could probably be more beneficial for the efficiency results if know-how and competence-based knowledge could be delivered. The assortment size proved to have a negative influence on the technical efficiency. However, a conflicting finding was made in the correlation matrix (Table 2), where a rather moderate positive correlation was found for the assortment size and the revenue obtained from table grapes. The economic size of farms has also been found to be positively related to farm efficiency (Carvahlo et al. 2008; Henriques et al. 2009; Latruffe et al. 2005; Manevska-Tasevska and Hansson 2011). This study analyzed grape production in three groups (regional/local wine grape varieties, European wine grape varieties and table grape varieties). More accurate and policy-relevant data support on the influence of grape assortment on farm efficiency could be obtained if three different analyses were conducted for farms specializing in these three groups of grape varieties.

From a farmer's perspective, growing an additional crop and thus higher diversification is often seen as a way to reduce risk when unexpected conditions arise. However, this requires more knowledge, both for production and managerial practices. There is currently no consensus regarding the influence of product differentiation on farm efficiency. It has been variously reported to be a restraining factor (Bojnec and Latruffe 2009; Haji 2007; Llewelyn and Williams 1996) or beneficial for farm efficiency (Brümmer 2001; Coelli and Fleming 2004). Coelli and Fleming (2004) argue that smallholders may benefit from the flexibility in production operations, while Brümmer (2001) found a positive impact of diversification on farm efficiency in the Slovenia. Another study on Slovenian farms (Bojnec and Latruffe 2009) found that the benefits of specialization outweigh the issue of harvest risk. Llewelyn and Williams (1996) argue that proposed government policies that encourage diversification of cropping practices in Java may decrease technical efficiency, but emphasize that the situation may change if

farmers improve their ability to grow new crops. For the vegetable-dominated producers in Ethiopia, a negative influence of crop diversification has been reported for allocative and economic efficiency (Haji 2007).

Changes to grape assortment need to be introduced in a gradual manner that will allow time for acquisition of the knowledge necessary for the newly planted varieties, as well as for a regular transformation process where the adaptive generalization will be organized along with the adaptive specialization (Chakravarthy 1986). Adaptive generalization does not necessarily imply taking steps for changes in technical aspects, since the net surplus gained by adaptive specialization can also be invested in managerial capacity, reduction of resource dependence, etc. (Chakravarthy 1986). Rural development involves a re-contextualization (Ventura and Milone 2000), and it should be performed after extensive consultation and discussion between government authorities as the main financier of the intervention and specialists. The organization of product assortment must also match production capacity and organizational technologies (Ventura and Milone 2000). Mantrala et al. (2009) view product assortment planning as a trade-off between consumer preferences, producer constraints, environmental factors and organization. In this study the influence of assortment on farm technical efficiency was analyzed from the producer perspective. However, as Macedonian viticulture is industry-orientated, the buyer perspective must also be considered. Further research in that direction is necessary.

To conclude, restructuring of the Macedonian viticulture assortment is one of the high-priority interventions for increasing the competitiveness of the grape and wine sector. This analysis of current farm technical efficiency showed huge potential for improvements in competitiveness. According to these findings, the ongoing revitalization and investments in grape assortment should primarily be directed towards regionally recognized varieties and table grape varieties. Grape variety diversification is generally not recommended.

References

- Afonso, A., and St. Aubyn, M. (2006). "Cross-country efficiency of secondary education provision: A semi-parametric analysis with non-discretionary inputs." *Economic Modelling*, 23(3), 476-491.
- Banker, R. D., Charnes, A., and Cooper, W. W. (1984). "Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis." *Management Science*, 30(9), 1078-1092.
- Bojnec, S., and Latruffe, L. (2009). "Determinants of technical efficiency of Slovenian farms." *Post-Communist Economies*, 21(1), 117-124.
- Brümmer, B. (2001). "Estimating confidence intervals for technical efficiency: the case of private farms in slovenia." *European Review of Agricultural Economics*, 28(3), 285-306.
- Brümmer, B., and Loy, J.-P. (2000). "The Technical Efficiency Impact of Farm Credit Programmes: A Case Study of Northern Germany." *Journal of Agricultural Economics*, 51(3), 405-418.
- Carvahlo, M. L., Henriques, P. D., Costa, F., and Pereira, R. (2008). "Characterization and technical efficiency of Portuguese wine farms" *European Association of Agricultural Economists, 2008 International congress*. Ghent, Belgium, August 26-29, 2008.
- Chakravarthy, B. S. (1986). "Measuring Strategic Performance." *Strategic Management Journal*, 7(5), 437-458.
- Charnes, A., Cooper, W. W., and Rhodes, E. (1978). "Measuring efficiency of decision-making units." *European Journal of Operational Research*, 2(6), 429-444.
- Coelli, T., and Fleming, E. (2004). "Diversification economies and specialisation efficiencies in a mixed food and coffee smallholder farming system in Papua New Guinea." *Agricultural Economics*, 31(2-3), 229-239.
- Coelli, T. J., Rao, D. S. P., O'Donnell, C. J., and Battese, G. E. (2005). *An introduction to efficiency and productivity analysis*, New York, USA: Springer Science+Business Media, LLC.

- Food and Agricultural Organization. (2009). "Argibusiness handbook, grapes and wines".
City: Food and Agricultural Organization (FAO): Investment Centre Division,
and Rural Infrastructure and Agro-Industries Division Rome, Italy.
- Haji, J. (2007). "Production efficiency of smallholders' vegetable-dominated mixed
farming system in eastern Ethiopia: A non-parametric approach." *Journal of
African Economies*, 16(1), 1-27.
- Hart, C., and Rafiq, M. (2006). "The dimensions of assortment: A proposed hierarchy of
assortment decision making." *The International Review of Retail, Distribution
and Consumer Research*, 16(3), 333-351.
- Henriques, P. D. D., Carvalho, M. L. D., and Fragoso, R. M. D. (2009). "Technical
efficiency of Portuguese wine farms." *New Medit*, 8(1), 4-9.
- Hoch, S. J., Bradlow, E. T., and Wansink, B. (1999). "The Variety of an Assortment."
Marketing Science, 18(4), 527-546.
- Kleinhanß, W., Murillo, C., San Juan, C., and Sperlich, S. (2007). "Efficiency, subsidies,
and environmental adaptation of animal farming under CAP." *Agricultural
Economics*, 36(1), 49-65.
- Krishnan, V., and Ulrich, K. T. (2001). "Product Development Decisions: A Review of
the Literature." *Management Science*, 47(1), 1-21.
- Larsén, K. (2010). "Effects of machinery-sharing arrangements on farm efficiency:
evidence from Sweden." *Agricultural Economics*, 41(5), 497-506.
- Latruffe, L., Balcombe, K., Davidova, S., and Zawalinska, K. (2005). "Technical and
scale efficiency of crop and livestock farms in Poland: Does specialization
matter?" *Agricultural Economics*, 32(3), 281-296.
- Latruffe, L., Davidova, S., and Balcombe, K. (2008). "Application of a double bootstrap
to the investigation of determinants of technical efficiency of farms in Central
Europe." *Journal of Productivity Analysis*, 29(2), 183-191.
- Latruffe, L., Guyomard, H., and Mouël, C. L. (2009). "The role of public subsidies on
farms' managerial efficiency: An application of a five-stage approach to France".
City: Working Paper INRA UMR SMART – LERECO N°09-05.

- Llewelyn, R. V., and Williams, J. R. (1996). "Nonparametric analysis of technical, pure technical, and scale efficiencies for food crop production in East Java, Indonesia." *Agricultural Economics*, 15(2), 113-126.
- MAFWE. (2007). *National agricultural and rural development strategy for the period 2007-2013*. Ministry of Agriculture, Fishery and Water Economy, Republic of Macedonia, Skopje.
- Manevska-Tasevska, G., and Hansson, H. (2011). "Does Managerial Behavior Determine Farm Technical Efficiency? A Case of Grape Production in an Economy in Transition." *Managerial and Decision Economics*, 32(6), 399-412.
- Mantrala, M. K., Levy, M., Kahn, B. E., Fox, E. J., Gaidarev, P., Dankworth, B., and Shah, D. (2009). "Why is Assortment Planning so Difficult for Retailers? A Framework and Research Agenda." *Journal of Retailing*, 85(1), 71-83.
- Nacka, M. (2011). *Marketing and competitiveness of wines, of teh Republic of Macedonia from aspect of industrial property*, St. Cyril and Methodius, Skopje.
- Oppewal, H., and Koelemeijer, K. (2005). "More choice is better: Effects of assortment size and composition on assortment evaluation." *International Journal of Research in Marketing*, 22(1), 45-60.
- Paul, C. J. M., and Nehring, R. (2005). "Product diversification, production systems, and economic performance in U.S. agricultural production." *Journal of Econometrics*, 126(2), 525-548.
- Ramdas, K. (2003). "Managing product variety: an integrative review and research directions." *Production and Operations Management*, 12(1), 79-101.
- Rezitis, A. N., Tsiboukas, K., and Tsoukalas, S. (2003). "Investigation of factors influencing the technical efficiency of agricultural producers participating in Farm Credit Programs: The case of Greece " *Journal of Agricultural and Applied Economics*, 35(3), 529-541.
- Simar, L., and Wilson, P., W. (1998). "Sensitivity anlysis of efficinecy score: How to bootstrap in nonparametric frontier models." *Management Science*, 4(1), 49-61.
- Simar, L., and Wilson, P. W. (2000). "Statistical inference in nonparametric frontier models: The state of the art." *Journal of Productivity Analysis*, 13(1), 49-78.

- Simar, L., and Wilson, P. W. (2007). "Estimation and inference in two-stage, semi-parametric models of production processes." *Journal of Econometrics*, 136(1), 31-64.
- Simar, L., and Wilson, P. W. (2008). "Statistical inference in nonparametric frontier models: Recent developments and perspectives", in H. O. Fried, C. A. K. Lovell, and S. S. Schmidt, (eds.), *The Measurement of Productive Efficiency and Productivity Change*. New York: Oxford University Press.
- SS0. (2007). "Agricultural Census of the Republic of Macedonia ". State Statistical Office of the Republic of Macedonia: Skopje.
- SS0. (2011). "Statistical yearbook of the Republic of Macedonia ". City: State Statistical Office of the Republic of Macedonia: Skopje.
- Ventura, F., and Milone, P. (2000). "Theory and Practice of Multi-Product Farms: Farm Butcheries in Umbria." *Sociologia Ruralis*, 40(4), 452-465.
- Zhu, X., Milán, D. R., and Oude, L. A. (2008). "Competitiveness of dairy farms in three countries: the role of CAP subsidies", EAAE, (ed.) *12th Congress of the European Association of Agricultural Economists*. Ghent, Belgium, August 26-29, 2008.